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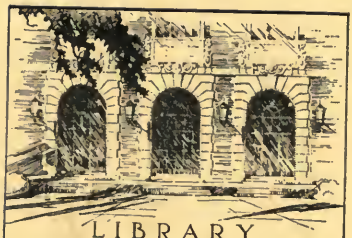

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A SILURIAN WORM AND ASSOCIATED FAUNA

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PREFACE

Lecthaylus gregarius, an extraordinary mid-Silurian worm-like organism, was described by the late Professor Stuart Weller as being "manifestly related to *Serpulites* and *Conularia*." The material upon which the original description was based was discovered by Professor Paul MacClintock (now of Princeton University) and a party of students who were collecting graptolites from rock excavated during the construction of the Calumet feeder for the Chicago Drainage Canal, near Blue Island, Illinois. The type specimen and the topotypes in Walker Museum, University of Chicago, were collected in 1924, chiefly by Messrs. T. A. Link, Edward De Losch and A. W. Slocom, and by Professors Paul MacClintock, D. J. Fisher and Stuart Weller.

In 1930, Mr. Bryan Patterson, of the Field Museum staff, was guided to the type locality and assisted in collecting by Messrs. Scott Griffith, Edward Espenshade and Jack Appel, of the University of Chicago. The party made an excellent collection of a large number of specimens representing this species. Encouraged by the success of the first trip, Mr. Patterson, accompanied by Mr. Frank Letl, also of the Field Museum staff, and Mr. Paul C. Letl, paid a second visit and secured several species of dendroid graptolites other than those previously known to occur there.

Later, Assistant Curator Sharat K. Roy of the Field Museum staff, who had not seen these fossils prior to their arrival at Field Museum, became interested in their unusual character and beautifully preserved condition, and while examining them noted a number of features not mentioned by the original author. It also appeared obvious to him that *Lecthaylus gregarius* was not related to *Serpulites*, much less to *Conularia*. Mr. Roy, therefore, accompanied by Mr. Patterson, visited the type locality, collected a number of complete specimens, and, unaware of any other interest in them, prepared a paper adding to Weller's original work such facts as might contribute to the existing knowledge of these fossils. When, however, the paper was nearly completed, he learned that Assistant Professor Carey Croneis of the University of Chicago was also interested in the subject and that he had been convinced for several years that the form in question was not closely related to *Serpulites* or to *Conularia*.

Accordingly, a joint paper presenting the results obtained by Messrs. Roy and Croneis is presented in the following pages.

OLIVER C. FARRINGTON

EXPLANATION OF PLATE XLII

(For detailed description see pages 237–238)

Fig. 1. Sa = shale containing *Lecthaylus gregarius* and associated fauna. Sb = shale containing only *Monograptus vomerinus*. Photograph No. 74582 Field Museum.

Fig. 2. Photograph showing interstratification of shale and dolomite. S = shale; D = dolomite. This shale is identical in composition and physical properties with Sa and Sb (Fig. 1) but is not fossil bearing. Photograph No. 74581 Field Museum.

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A SILURIAN WORM AND ASSOCIATED FAUNA

BY

SHARAT KUMAR ROY AND CAREY CRONEIS

INTRODUCTION

In 1925, the late Professor Stuart Weller[1] proposed the name *Lecthaylus gregarius* for a certain mid-Silurian worm-like organism which he, as referred to in the Preface, considered "manifestly related to *Serpulites* and *Conularia*." The present writers, however, have differed from this view and have taken the privilege of presenting the conclusions reached by them as a result of their joint investigations. The writers have also recently learned that Professor Weller also differed from his original conclusions and was desirous of modifying them at a later date.

The writers wish to record their indebtedness to all of the collectors mentioned in the Preface. Their thanks are also due to Dr. Oliver C. Farrington for a critical reading of the manuscript, to Dr. Rudolf Ruedemann for helpful information and for assistance in the identification of the graptolites associated with *Lecthaylus gregarius*, to Dr. B. E. Dahlgren for information regarding recent Annulata, and to Mr. H. W. Nichols for chemical analysis of the fossils and rocks in which they occur.

[1]Weller, Stuart, A New Type of Silurian Worm, Jour. Geol., Vol. 33, 1925, pp. 540–544.

ORIGINAL DESCRIPTION[1]

LECTHAYLUS GREGARIUS Weller.

The individuals of this species were flask-shaped bodies attaining a total length of from 70 to 75 millimeters or more. In the flattened condition as they occur in the rock, the greatest width is about 12 millimeters at a distance of from 15 to 18 millimeters from the base. Above the line of greatest width the body tapers gradually to a little less than 3 millimeters, beyond which point the sides become nearly parallel through some 20 millimeters of the distal portion. When reconstructed from the crushed condition, each one of the individuals would possess an expanded, bulblike proximal portion, tapering out into an elongate, slender, tubular portion distally. These flask-shaped bodies are attached at the base of the broader, bulblike portion, in clusters or perhaps singly in some cases. In no example observed is the actual surface of attachment clearly exhibited but there seems to be little or no narrowing of the body toward what must have been the disklike base. The number of individuals in the groups or clusters is variable; in some of the groups observed there may be as many as ten or more individuals. The bulblike proximal portions are in close proximity, and the slender, tubelike distal portions seem to have been more or less flexible during life. In its proximal, broader portion, the surface is marked by distinct transverse lines about 0.2 millimeter apart near the base, becoming more widely spaced above, where some are 0.5 to 1 millimeter apart a short distance above the line of greatest width. As the sides of the body taper distally, the transverse markings disappear, or at least become nearly obscured by conspicuous, longitudinal, more or less irregular, wrinkle-like markings, which are more or less wavy and become indistinct toward the distal extremities, where they merge into a more or less irregularly roughened surface. Upon some examples the markings of the tubular, distal portion seem to exhibit a somewhat regular succession of elongate, diamond-shaped areas. In some of the individuals one or two of the longitudinal markings of the distal portion of the body, as seen upon one exposed surface, continue proximally across the broader, transversely marked portion, suggesting that this part of the body may have been divided longitudinally into four or more sections. There is no uniformity in this last feature, however, and the longitudinal markings may be fractures produced by the flattening of the bodies as they became buried in the inclosing sediments.

Among the specimens which have been observed considerable variation is exhibited, although many of the specimens which have been collected are more or less fragmentary, so that the dimensions and proportions are not determinable. In one example the broader, proximal, transversely marked portion of the body attains a length of at least 60 millimeters, but the narrower, distal portion of the specimen is only partially preserved, so that it is not possible to determine whether the relative proportions between the two parts remain the same.

In the collection there are one or two groups of individuals which seem to be attached to another example of the same animal. In such cases the younger, attached individuals are much smaller than the host upon which they are growing, and they stand out at nearly right angles in all directions from the tube to which they are attached. None of these individuals are really well preserved, which

[1] *Op. cit.*, p. 541.

may be due to the fact that the tube walls are thinner and more delicate in the younger examples.

The material of which these fossils are constituted is jet black in color and apparently carbonaceous, and they stand out in strong contrast upon the surfaces of the rock which contains them. The appearance of this material is not unlike that of some of the examples of *Serpulites* that have been described, and examples of *Conularia* in some conditions of preservation seem to be entirely similar in character.

REVISED DESCRIPTION

LECTHAYLUS GREGARIUS Weller. Plate XLIII, figs. 1–10; Plate XLIV, figs. 1–3.

No. P 23254 Field Museum. No. 31533 Walker Museum, University of Chicago. Topotypes.

Shape:—Body elongate flask-shaped in general outline. Probably sub-cylindrical and straight during life, but highly compressed and generally curved in the fossil state. Broad part of the flask-like body approximately as long as the tapering portion. This proportion, however, differs appreciably. In some instances the broader portion is longer and vice versa. From the point of the greatest width, which is at about the mid-length of the broader portion, the individuals taper at first very gradually and then more rapidly, but, as a rule, at a short distance from the end, there is no further reduction in the width. The sides then become essentially parallel. The tapering portion, however, was not as narrow as it might appear in the fossil state. The narrowing has been considerably accentuated by shrinkage, as is evidenced by a great many surface wrinkles. A typical example may be seen in Plate XLIII, fig. 5.

Size:—The average length, as determined from the measurements of many complete specimens, is 75 mm., or about 3 inches. The greatest width of the broader portion is approximately 10 mm., or about three-eighths of an inch. An interesting fact is that the width, barring immature specimens, does not vary in any appreciable manner in relation to the length.

Although 75 mm. may be taken as an average length for individuals of this species, numerous specimens whose body outlines are essentially of the proportions described above, are not more than 35 mm. in length. On the other hand, in Field Museum collection there is an incomplete specimen (Plate XLIII, fig. 6) which is 123 mm. in length in spite of the fact that the greater part of the tapering portion is missing. This individual during life undoubtedly had a length of nearly, if not quite, 225 mm. or 9 inches.

EXPLANATION OF PLATE XLIII

LECTHAYLUS GREGARIUS Weller, page 234

Fig. 1. A typical adult individual. Slightly enlarged.

Figs. 2, 3, 5. Individuals with proboscis-like prolongations (not common). Fig. 3 also shows longitudinal fractures. Natural size.

Fig. 4. A young specimen with sucker-like disk. Natural size.

Fig. 6. An unusually large specimen in which most of the tapering portion is missing. Slightly enlarged.

Figs. 7–9. Enlargements of surface structures showing gradual widening of the transverse ribs, also longitudinal fractures.

Fig. 10. Eight adult individuals clustered into a group with their proximal ends together. Natural size.

Figs. 1, 4, 5–9. No. P 23245 Field Museum; Figs. 2, 3, 10. No. 31533, Walker Museum, University of Chicago.

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Surface markings:—The entire surface of the body is marked by encircling, finely striate, transverse ribs or rings. On the broader portion of the body the rings are closely set and are usually separated by slight grooves, but in some instances they appear to be fused together. An average specimen having a length of 75 mm. contains about 250 rings. The rings are about 0.2 mm. apart, becoming more widely spaced (0.5 to 1 mm.) toward the narrow portion of the body. In the area of most rapid diminution the rings become more or less indistinct and the surface is occupied by a great many irregular longitudinal wrinkles. The long "longitudinal markings" or groove-like lines (Plate XLIII, fig. 3) which occur on a number of specimens and which sometimes occupy the entire lengths of the individuals, are tensional fractures produced by the flattening of the body under the weight of the enclosing sediments. That these are tensional fractures can be plainly seen in thin sections.

Upon slight grinding, the transverse rings of the surface of the fossil quickly disappear and the body appears smooth. This, however, is not certain evidence that the body was not segmented internally. The integument is so highly carbonized that internal features are not likely to be preserved. That the organism, however, was probably not metameric, is further indicated by the fact that so far as we have been able to examine the slight filling, which in some specimens occurs within the flattened integument, it is entirely without constrictions.

Body appendages:—Careful examination of more than one hundred specimens of various sizes and different states of preservation failed to reveal parapodia, tentacles or setae or probable points of attachment for such appendages. It is therefore, unlikely, though not entirely impossible, that appendages of any kind ever existed.

Orientation:—The transverse markings described above show little or no variation from one side of the body to the other, so that it has not been possible to distinguish between the ventral and dorsal sides. Moreover, cephalization or other differentiation into body regions has not been observed. The terms distal and proximal, as they were used by Weller for the narrow and broad portions respectively, can, however, be continued with advantage. There is no doubt that *Lecthaylus gregarius* characteristically attached itself by its broader end, which is, therefore, its proximal end. In every instance, wherever there are several individuals together, they have been found to cluster themselves by means of their proximal ends, leaving the distal ends free from one another (Plate XLIII, fig. 10). There is also

some reason for supposing the proximal end to be the anterior end. First of all, a sucker-like structure (Plate XLIII, fig. 4), at least in two instances, has been observed, but so many distorted specimens occur in the collections that we are unable to state positively that *Lecthaylus* was provided with a suctorial disk. Then again, several individuals present well-preserved proboscis-like prolongations of their proximal extremities (Plate XLIII, figs. 2, 3 and 5). This, we are inclined to think, is a fundamental feature of *Lecthaylus*. If so, the rarity of this feature in the fossil condition may be explained on the basis that in nearly all the specimens collected the proboscis had been invaginated before the death of the individual. Dissection of the integument in the presumably anterior part of the body of a number of specimens, however, failed either to controvert or to confirm this idea. The failure to arrive at a definite conclusion, however, was anticipated, since the specimens are so highly carbonized that one would expect the invaginated proboscis to be completely fused with the integument, thus rendering the former indistinguishable from the latter.

Habit and locomotion:—*Lecthaylus* was ordinarily gregarious in habit. It is not uncommon to find ten to twenty individuals clustered about a small central area of attachment. Under such a condition the proximal ends are usually closely crowded together, whereas the narrow, distal extremities are spread out fan-wise in a semicircular to nearly circular fashion (Plate XLIII, fig. 10). However, in spite of the usual gregarious habit of *Lecthaylus*, many are found as scattered individuals.

The attachment of a number of small individuals supposedly to a larger one, described by Weller, is extremely uncommon, and in all cases the preservation is such that there is a great deal of uncertainty as to whether the young are fixed to the body of a larger individual or to some foreign object.

The exact mode of locomotion of *Lecthaylus* is not known. The creature might have crawled or swum by throwing its body into a series of wave-like folds, or, like the modern leeches, it may have progressed by loops by attaching its proximal end and moving the distal end forward, finally loosening the proximal end to find a new hold. The manner in which the individuals are grouped together strongly suggests that the distal ends moved to and fro as if to gain some knowledge of the surroundings. That the body of *Lecthaylus* was flexible is clearly shown by the twists and turns it was able to make and by the many wrinkles on its surface. The flexibility, of course, was possible because of the creature's ability to telescope the surface

rings together on one side and to extend the grooves on the opposite. In other words, the structural device of its body rings was like that of a bellows or "accordion plaiting." This is plainly seen wherever the body is curved (Plate XLIV, fig. 2).

Mode of preservation:—All the specimens of *Lecthaylus* so far collected are either carbonized original integuments or the impressions of the same. Often the breaking of the matrix shatters the carbonized material, leaving only the mold.

The graptolites associated with *Lecthaylus* have a similar type of preservation, and since they are generally regarded as having a chitinous skeleton, it is most likely that *Lecthaylus* also had an integument chitinoid in character. The material of the fossils, however, is much more anthracitic than is ordinarily seen in typical cases of carbonization of organisms of this nature.

Composition and physical properties:—Anthracitic, 95.3 per cent organic matter. Ash[1] infusible, of pale buff, fire-brick color. When heated in the open tube the material of the fossil is infusible and gives off empyreumatic fumes. Fracture conchoidal. Luster resinous to dull. Color brownish black to jet black, usually the latter.

Locality and horizon:—*Lecthaylus gregarius* is found in the rock excavated during the construction of the Calumet feeder for the Chicago Drainage Canal, a little southwest of Blue Island, Illinois. It occurs in a bed of fine-grained, grayish brown, calcareous (slightly dolomitic) shale, overlaid and underlaid by a buff-colored dolomite of Upper Lockport Group, probably Racine[2] of eastern Wisconsin and equivalent to the Chert Bed[3] (Bed 12) of the Niagaran of Hamilton, Ontario. As this dolomite is found at the top of the dump pile it doubtless constitutes the lowermost rock excavated. The bed of shale is very thinly laminated and is between eighteen inches and two feet in thickness (Plate XLII, fig. 1). Some of the laminae are dotted with subcircular, dark blotches, probably of organic origin. *Lecthay-*

[1] The ash is so nearly identical with the ash of carbonized plant material that the possibility of *L. gregarius* being a primitive plant was considered. No recorded plant, however, is known to possess such worm-like characters as does the species in question. Furthermore, seaweeds, as a rule, do not produce much coal. Dr. Ruedemann also supports this view by stating, "I have not seen any Paleozoic seaweed that would produce so much coal." (Letter to Sharat K. Roy, March 24, 1931.)

[2] Savage, T. E., Silurian Rocks of Illinois, Bull. Geol. Soc. Amer., Vol. 37, 1926, pp. 524–525, 531.
Bassler, R. S., U. S. Nat. Mus. Bull., No. 92, Vol. II, 1915, Plate 3.

[3] Spencer, J. W., Canadian Naturalist, Vol. X, 1883, p. 136. Whether the horizon in question is equivalent to the Racine or not the writers cannot say definitely but that it is the same as the Chert Bed of Hamilton, Ontario, is certain, as revealed by the graptolites associated with *Lecthaylus gregarius*.

lus gregarius, however, as well as the dendroid graptolites and the inarticulate brachiopods are found only in a restricted part of this main shale bed (Plate XLII, fig. 1, Sa). *Monograptus vomerinus* (Nich.) occurs throughout the entire bed (Plate XLII, fig. 1, Sa, Sb).

Other thin layers of shale (Plate XLII, fig. 2), between two and four inches thick, also occur interstratified with the dolomite. None, however, has proven fossiliferous, though in other respects they are identical with those that have yielded *L. gregarius* and its associated fauna.

All the shale beds occur abruptly in the dolomite, with no gradual transition either above or below. This would suggest that the shales were deposited as silts by temporary variations in slow-moving currents rather than by changes of level.

Composition of the shale in which *L. gregarius* and its associates occur:

	Per cent
Clay	47.35
Carbonate of lime	24.83
Carbonate of magnesia	25.70
	97.88

All acid-soluble lime and magnesia have been calculated as carbonate, although it is probable that a small portion of each was leached from siliceous mineral powder in the clay.

Composition of the dolomite:

	Per cent
Clay	24.10
Carbonate of lime	43.45
Carbonate of magnesia	31.68
	99.23

Ratio of $CaCO_3$: $MgCO_3$: 37.84: 42.16.

Ratio for true dolomite: 54.35: 45.65.

The dolomite passes the slaking test for cement rock.

RELATIONSHIPS OF LECTHAYLUS GREGARIUS

In the studies of *Lecthaylus gregarius*, the following organisms, modern and fossil, have been found to possess either allied characters or superficial similarities:

(1) *Serpulites:*—Despite Weller's statement, the present writers regard the relationship of *Lecthaylus* to *Serpulites* as being remote. *Serpulites* is characterized by long, generally smooth, more or less compressed (elliptical in cross section), slightly bent, calcareous or calcareo-phosphatic tubes which usually show marginal welts and fre-

EXPLANATION OF PLATE XLIV

LECTHAYLUS GREGARIUS Weller, page 234

Fig. 1. Enlargement of a well-preserved adult individual. Proximal and distal extremities not shown. No. P 23245 Field Museum.

Fig. 2. Enlargement of the curved portion of an individual showing the elasticity of the body. The transverse ribs are close together on the concave side, whereas on the convex side they are farther apart. No. P 23245 Field Museum.

Fig. 3. Enlargement of the tapering portion showing irregular, longitudinal wrinkles. No. P 23245 Field Museum.

PROTOSCOLEX RUEDEMANNI sp. nov., page 245–246

Fig. 4. Slightly enlarged. No. 22375, Walker Museum, University of Chicago.

INCERTAE SEDIS, page 246

Figs. 5, 6. Natural size. Nos. 22374.1, 22374.2, Walker Museum, University of Chicago.

ORBICULOIDEA sp., page 246–247

Fig. 7. A pedicle valve. Slightly enlarged. No. 22376, Walker Museum, University of Chicago.

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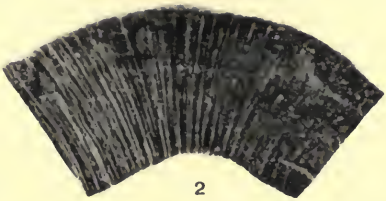

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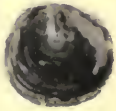

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quently possess chitinoid setae. In addition, authors in general include under this genus similar tubes of chitinous material with minor surface markings. *Lecthaylus*, however, is not a tube, either built or secreted, nor has it any of the distinctive characters of *Serpulites* enumerated above. It is plainly and clearly a compressed, carbonized, actual integument of the organism and, as such, it cannot be referred to *Serpulites* or any other Tubicola. Some specimens of *Lecthaylus* do exhibit slight thickened lateral margins or marginal welts, but they are what one would expect in any sub-cylindrical organism that has been subject to compression.

Dr. Ruedemann suggests (letter to Sharat K. Roy, March 24, 1931) that it is possible that *L. gregarius* is a case in which the animal lived. He also explains the deformation of the body by stating that "the longitudinal wrinkles on the distal portion show that, being softer, it contracted much more than the proximal one, post mortem, and the proximal portion is, in some specimens that I have, so swollen that it looks as if the animal had retreated and contracted itself into that portion before death." Ruedemann's explanations doubtless seem very plausible and one would at once accept them if other features of the organism in question were not brought to light with certainty. The objections to considering *L. gregarius* a case, are: (1) the closed, proboscis-like prolongation of its proximal end; (2) its composition of 95.3 per cent organic matter; (3) the irregularity in the arrangement of the body rings; (4) the flexibility of the body; and (5) the finding of a number of individuals clustered into groups with their proximal ends together.

(2) *Conularia:*—The relationship of *Lecthaylus* to *Conularia* is still more remote than that to *Serpulites*. *Conularia* is rectangular to rhombic in cross section, with transversely striated, lateral faces which are divided into longitudinal halves by a median groove. The posterior portion of the shell is ordinarily septate. *Lecthaylus* is ovate to round in cross section, its transverse markings are completely encircling, it is flask-shaped rather than conical in outline, and finally it is non-septate. Miss Slater's[1] figure of *Conularia tenuis*, which Weller cited, does indicate that the gregarious habit of *Lecthaylus* was duplicated in at least one species of *Conularia*. This fact, however, is nearly if not quite irrelevant so far as zoological relationships are concerned. Moreover, the individuals of *C. tenuis* are attached at their posterior extremities, whereas those of *L. gregarius* apparently are attached at their anterior ends.

[1] Slater, Ida, British Conulariae, Mong. Pal. Soc., 1907, Plate 2, fig. 1.

(3) *Protoscolex:*—The genus *Protoscolex* was proposed by Ulrich[1] in 1878 for four species of worms collected from the Economy formation near Covington, Kentucky. Miller and Faber[2] in 1892, Bather[3] in 1920 and Ruedemann[4] in 1925 have described other species of this early Paleozoic worm. The two latter writers regard *Protoscolex* as an Oligochaete of ancestrally aquatic type, from which the modern terrestrial Perichaetidae may have been derived. One of the specimens of *P. batheri* described by Ruedemann shows a swelling which has been interpreted as a clitellum. In this respect it differs from all of its congeners. The absence of a clitellum in other specimens of *Protoscolex*, however, is regarded by Bather as not to be unexpected in so primitive a type of Oligochaete.

L. gregarius has certain resemblances to *Protoscolex*, especially to *P. batheri*, but that it cannot be referred to *Protoscolex* is shown by the fact that the outline of *Lecthaylus* is distinctly flask-like, its surface markings are without definite papillae and differ in different parts of the body. Furthermore, in the great number of specimens thus far examined, in not a single individual has there been found anything suggesting the possession of a clitellum or any evidence indicating that *Lecthaylus* was segmented.

(4) *Hirudinea:*—In some respects *Lecthaylus* presents strong resemblances to the leeches. The surface markings of the proximal end and the general body outline are similar to that of *Glossophonia*. Had *Lecthaylus* possessed suctorial disks (the possibility but improbability of this has been already indicated), the similarity would be most striking. Another interesting point in this connection is the fact that *Glossophonia* carries its eggs on its ventral surface, where the young remain attached for a period after they are hatched. If the young specimens of *Lecthaylus* were actually attached to the body of a larger individual, as Weller indicated, it would have been a Silurian duplication of a modern habit of the leeches. But the probable absence of definite suctorial disks and of body segmentation in *Lecthaylus* must be regarded as evidence against placing it with the Hirudinea. This is true also of the surface markings of the distal portions of *Lecthaylus*. These are distinctly not leech-like.

[1] Ulrich, E. O., Jour. Cin. Soc. Nat. Hist., Vol. 1, 1878, p. 89.

[2] Miller, S. A., and Faber, Charles, Jour. Cin. Soc. Nat. Hist., Vol. 15, 1892, p. 83.

[3] Bather, F. A., Ann. and Mag. Nat. Hist., ser. 9, Vol. 5, 1920, pp. 124–132.

[4] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, p. 40.

(5) *Bertiella:*—Ruedemann[1] has described from the Bertie waterlime "a very plump worm" of uncertain affinities which he has called *Bertiella obesa*. Some of the specimens of *Lecthaylus* look like the illustration of the genotype of *Bertiella*, but since the latter apparently possessed parapodia and jaws and had in addition anterior and posterior configurations differing from those of *Lecthaylus*, the similarity of these two "worms" is probably entirely superficial.

(6) *Gephyrea:*—The gephyrean worms are subcylindrical, exclusively marine animals. They are devoid of segmentation in the adult state, without parapodia, and nearly or quite devoid of setae. They possess either an introvert at whose extremity there is a mouth surrounded by tentacles, or a retractile proboscis with a basal mouth. The arms are either posterior and terminal or anterior and dorsal.

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On page 241, line 13, *for* arms are *read* anus is.

bodies, devoid of parapodia, with simple enteric canal, with proboscis papillose and with hooks at anterior and posterior extremities. They are, therefore, unlike the modern gephyreans in possessing segments and in having simple rather than somewhat complicated enteric canals. But these differences, according to Walcott, are only to be expected in such ancient forms as are *Ottoia* and *Banffia*.

Lecthaylus, despite the fact that it is apparently unsegmented, has a number of features which resemble *Ottoia*. Like *Ottoia*, it in all probability had a simple enteric canal, was devoid of parapodia, and apparently possessed a somewhat similar, though not papillose proboscis. It was, however, dissimilar in body outline, in surface markings, and in lacking segmentation.

Of all the modern Gephyrea, *Lecthaylus* shows the strongest resemblance to *Sipunculoidea*. The chief points of similarity are the lack of segmentation, the apparent possession of a proboscis and the analogy of the transverse surface markings. The differences are the usual relative complexity of the sipunculoid intestinal tract and

[1] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, p. 43, Plate 14, figs. 3–4.

[2] Walcott, C. D., Smithson. Misc. Coll., Vol. 57, No. 5, 1911, pp. 128–130.

[3] Ehlers, E., Paleontographica, Vol. VII, 1868, p. 166.

(3) *Protoscolex:*—The genus *Protoscolex* was proposed by Ulrich[1] in 1878 for four species of worms collected from the Economy formation near Covington, Kentucky. Miller and Faber[2] in 1892, Bather[3] in 1920 and Ruedemann[4] in 1925 have described other species of this early Paleozoic worm. The two latter writers regard *Protoscolex* as an Oligochaete of ancestrally aquatic type, from which the modern terrestrial Perichaetidae may have been derived. One of the specimens of *P. batheri* described by Ruedemann shows a swelling which has been interpreted as a clitellum. In this respect it differs from all of its congeners. The absence of a clitellum in other specimens of *Protoscolex*, however, is regarded by Bather as not to be unexpected in so primitive a type of Oligochaete.

L. arenarius has certain resemblances to *Protoscolex*, especially to

(4) *Hirudinea:*—In some respects *Lecthaylus* presents strong resemblances to the leeches. The surface markings of the proximal end and the general body outline are similar to that of *Glossophonia*. Had *Lecthaylus* possessed suctorial disks (the possibility but improbability of this has been already indicated), the similarity would be most striking. Another interesting point in this connection is the fact that *Glossophonia* carries its eggs on its ventral surface, where the young remain attached for a period after they are hatched. If the young specimens of *Lecthaylus* were actually attached to the body of a larger individual, as Weller indicated, it would have been a Silurian duplication of a modern habit of the leeches. But the probable absence of definite suctorial disks and of body segmentation in *Lecthaylus* must be regarded as evidence against placing it with the Hirudinea. This is true also of the surface markings of the distal portions of *Lecthaylus*. These are distinctly not leech-like.

[1] Ulrich, E. O., Jour. Cin. Soc. Nat. Hist., Vol. 1, 1878, p. 89.

[2] Miller, S. A., and Faber, Charles, Jour. Cin. Soc. Nat. Hist., Vol. 15, 1892, p. 83.

[3] Bather, F. A., Ann. and Mag. Nat. Hist., ser. 9, Vol. 5, 1920, pp. 124–132.

[4] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, p. 40.

(5) *Bertiella:*—Ruedemann[1] has described from the Bertie waterlime "a very plump worm" of uncertain affinities which he has called *Bertiella obesa.* Some of the specimens of *Lecthaylus* look like the illustration of the genotype of *Bertiella,* but since the latter apparently possessed parapodia and jaws and had in addition anterior and posterior configurations differing from those of *Lecthaylus,* the similarity of these two "worms" is probably entirely superficial.

(6) *Gephyrea:*—The gephyrean worms are subcylindrical, exclusively marine animals. They are devoid of segmentation in the adult state, without parapodia, and nearly or quite devoid of setae. They possess either an introvert at whose extremity there is a mouth surrounded by tentacles, or a retractile proboscis with a basal mouth. The arms are either posterior and terminal or anterior and dorsal.

The Cambrian genera, *Ottoia* and *Banffia,* referred to this class by Walcott[2] are essentially the only fossil worms thus far classed as gephyrean which are not based on borings, trails, or obscure impressions, although Ehlers[3] as early as 1868 very doubtfully referred a few fairly well-preserved worms of the genus *Epitrachys* from the lithographic limestone of Solenhofen to the Gephyrea. Both *Ottoia* and *Banffia* are characterized by cylindrical, elongate, segmented bodies, devoid of parapodia, with simple enteric canal, with proboscis papillose and with hooks at anterior and posterior extremities. They are, therefore, unlike the modern gephyreans in possessing segments and in having simple rather than somewhat complicated enteric canals. But these differences, according to Walcott, are only to be expected in such ancient forms as are *Ottoia* and *Banffia.*

Lecthaylus, despite the fact that it is apparently unsegmented, has a number of features which resemble *Ottoia.* Like *Ottoia,* it in all probability had a simple enteric canal, was devoid of parapodia, and apparently possessed a somewhat similar, though not papillose proboscis. It was, however, dissimilar in body outline, in surface markings, and in lacking segmentation.

Of all the modern Gephyrea, *Lecthaylus* shows the strongest resemblance to *Sipunculoidea.* The chief points of similarity are the lack of segmentation, the apparent possession of a proboscis and the analogy of the transverse surface markings. The differences are the usual relative complexity of the sipunculoid intestinal tract and

[1] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, p. 43, Plate 14, figs. 3–4.

[2] Walcott, C. D., Smithson. Misc. Coll., Vol. 57, No. 5, 1911, pp. 128–130.

[3] Ehlers, E., Paleontographica, Vol. VII, 1868, p. 166.

the lack in *Lecthaylus* of the common tentacular crown as well as the longitudinal surface markings such as are seen in *Sipunculus nudus*. The similarities of *Lecthaylus* and the *Sipunculoidea*, however, assume greater significance, and the differences become of lesser import when the following facts are considered. A few of the *Sipunculoidea*, such as *Onchnisoma* and *Tylosoma*, like *Lecthaylus*, have no tentacles; *Tylosoma*, as is also the case with *Lecthaylus*, is not certainly known to possess an introvert; and *Phascolion*, *Golfingia* and *Petalosoma* possess relatively simple enteric canals.

It, therefore, is apparent that although *Lecthaylus* is not similar to any modern Gephyrean genus, nevertheless a great many of its characteristics are duplicated in a group of Gephyrean genera, and thus it seems to the writers that it could be, at least doubtfully, referred to this admittedly heterogeneous assemblage of worms. On the other hand, it is by no means impossible that the species in question, like many others in the past, became extinct, leaving no descendants, or if any were left they have since so changed that they could not be now recognized from the ancestral form. The time that has elapsed since the Silurian is so enormously long that an interpretation of this kind does not seem to be out of harmony with the present knowledge of organic evolution and extinction.

ASSOCIATED FAUNA

The fauna associated with *Lecthaylus gregarius* comprises both monograptus and dendroid graptolites, a few inarticulate brachiopods and several very poorly preserved worms of various types.

Class GRAPTOLITOIDEA Lapworth

Order DENDROIDEA Nicholson

Family DENDROGRAPTIDAE Roemer

Genus DICTYONEMA Hall

DICTYONEMA RETIFORME (Hall). Plate XLV, fig. 1.

Gorgonia(?) *retiformis* Hall, Rep. Surv. 4th Geol. Dist. New York, 1843, p. 115, fig. 1. See Bassler, U. S. Nat. Mus., Bull. 92, Vol. I, 1915, p. 426, for synonyms and further references.

EXPLANATION OF PLATE XLV

DICTYONEMA RETIFORME (Hall), pages 242–243

Fig. 1. A portion of a rhabdosome showing thecae. Natural size. No. P 23306 Field Museum.

DICTYONEMA CRASSIBASALE Gurley, page 243

Fig. 2. An incomplete specimen. Natural size. No. P 23307 Field Museum.

DESMOGRAPTUS MICRONEMATODES (Spencer), page 244

Figs. 3, 4, 6, 8. Different specimens showing variations in branching. Natural size. No. P 23310 Field Museum.

DICTYONEMA TENELLUM Spencer, page 243

Fig. 5. An incomplete specimen. Natural size. No. P 23308 Field Museum.

PALAEODICTYOTA BELLA (Hall and Whitfield), page 244

Fig 7. An incomplete specimen. Natural size. No. P 23309 Field Museum.

MONOGRAPTUS VOMERINUS (Nicholson), pages 244–245

Figs. 9, 10. Two individuals showing different modes of compression of the thecae. Natural size.

Figs. 11, 12, 13. Enlarged.

Fig. 14. Dorsal view. Enlarged.

Figs. 9–14. No. P 23311 Field Museum.

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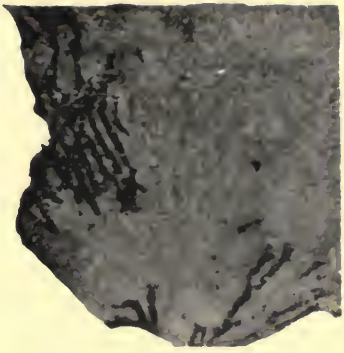

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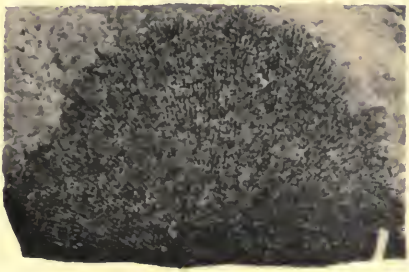

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Dictyonema retiforme (Hall), Ruedemann, N. Y. State Mus., Bull. No. 265, 1925, p. 25.

This species is represented in the Field Museum collection by a single specimen only. It is a portion of rhabdosome which shows thecae.

Horizon and locality:—Upper Lockport Shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23306 Field Museum.

DICTYONEMA CRASSIBASALE(?) Gurley. Plate XLV, fig. 2.

Dictyonema gracile Spencer (not Hall), Trans. Acad. Sci. St. Louis, Vol. IV, 1884, pp. 573–574, Plate 2, figs. 2, 3; Bull. Mus. Univ. State Missouri, Vol. 1, 1884, p. 24, Plate 2, figs. 2, 2a, 3; Bassler, U. S. Nat. Mus., Bull. 65, 1909, pp. 19–24, text figs. 21–25, Plate 3, fig. 1; U. S. Nat. Mus., Bull. 92, Vol. I, 1915, p. 422; Ruedemann, N. Y. State Mus., Bull. No. 265, 1925, p. 22, text figs. 12, 13, Plate 1, fig. 1.

There are two specimens in the Field Museum collection but both of them are too poorly preserved to admit of more accurate specific determination.

Horizon and locality:—Upper Lockport Shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23307 Field Museum.

DICTYONEMA TENELLUM Spencer. Plate XLV, fig. 5.

Dictyonema tenellum Spencer, Canadian Nat., Vol. VIII, 1878, pp. 458–459.

Dictyonema tenellum Spencer, Canadian Nat., Vol. X, 1882, p. 165; Trans. Acad. Sci. St. Louis, Vol. IV, 1884, pp. 564, 576 (not Plate I, fig. 13); Miller, North Amer. Geol. and Pal., 1889, p. 185; Gurley, Jour. Geol., Vol. IV, 1896, pp. 96, 308; Bassler, U. S. Nat. Mus., Bull. 65, 1909, pp. 28–30, text figs. 32, 33, Plate 2, fig. 4; Bassler, U. S. Nat. Mus., Bull. 92, Vol. I, 1915, p. 427.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23308 Field Museum.

Genus PALAEODICTYOTA Whitfield (emend. Ruedemann)

PALAEODICTYOTA BELLA (Hall and Whitfield). Plate XLV, fig. 7.

Inocaulis bella Hall and Whitfield, Geol. Surv. Ohio Pal., Vol. II, 1875, p. 122, Plate 6, fig. 2; Spencer, Canadian Nat., Vol. VIII, 1875, p. 458; Vol. X, 1882, p. 65; Bull. Mus. Univ. State Missouri, Vol. I, 1884, pp. 14, 35; Trans. Acad. Sci. St. Louis, Vol. IV, 1884, pp. 564, 585; Gurley, Jour. Geol., Vol. IV, 1896, pp. 99, 308.

Palaeodictyota bella (Hall and Whitfield), Ruedemann, Mem. New York State Mus., Mem. 11, Pt. 2, 1908, p. 203, text figs. 105–107, Plate 3, fig. 7; Bassler, U. S. Nat. Mus., Bull. 92, Vol. II, 1915, p. 937.

The form of the thecae is not shown in the specimen at hand. For this reason the species to which it is referred cannot be readily distinguished from *Dictyonema polymorphum* Gurley.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23309 Field Museum.

Genus DESMOGRAPTUS Hopkinson

DESMOGRAPTUS MICRONEMATODES (Spencer). Plate XLV, figs. 3, 4, 6–7.

Calyptograptus micronematodes Spencer, Canadian Nat., Vol. X, 1882, p. 165 (nom. nud.); Trans. Acad. Sci. St. Louis, Vol. IV, 1884, p. 579, Plate 3, figs. 4, 4a; Bull. Mus. Univ. State Missouri, Vol. I, 1884, p. 29, Plate 3, figs. 4, 4a; Gurley, Jour. Geol., Vol. 4, 1896, pp. 93, 308; Bassler, U. S. Nat. Mus., Bull. 65, 1909, pp. 39, 40, figs. 49, 50; Bassler, U. S. Nat. Mus., Bull. 92, Vol. I, p. 170.

Desmograptus micronematodes (Spencer), Ruedemann, New York State Mus., Bull. No. 265, 1925, pp. 21–22, text figs. 7–11.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23310 Field Museum.

Suborder AXONOPHORA Frech (emend. Ruedemann)
Family MONOGRAPTIDAE Lapworth
Genus MONOGRAPTUS Geinitz

MONOGRAPTUS VOMERINUS (Nicholson). Plate XLV, figs. 9–14.

Graptolithus colonus Barrande, Grapt. de Bohême, 1850, Plate II, fig. 4; Suess, Bohemische Graptolithen, 1851, Plate VIII, figs. a–f.

Graptolites priodon Nicholson, Quart. Journ. Geol. Soc., Vol. XXIV, 1868, Plate XV, figs. 7, 8.

Graptolites vomerinus Nicholson, Mong. Brit. Grapt., 1872, p. 53, fig. 21.

Monograptus vomerinus Lapworth, Geol. Mag., dec. II, Vol. III, 1876, p. 353, Plate XII, figs. 6a–e; Elles, Quart. Jour. Geol. Soc., Vol. LVI, 1900, p. 403.

Monograptus vomerinus Elles and Wood, Mong. Brit. Grapt., 1910, pp. 409–411, text figs. 275a–f, Plate XLI, figs. 1a–e; Weller, Jour. Geol., Vol. 33, 1925, p. 541.

This species is the most abundant one at Blue Island, Illinois. It has different appearances because of different modes of compression.

Remarks:—*M. vomerinus* has not hitherto been known to occur in North America. In England it is found in the overlying Wenlock zones and is described as being below along with *M. priodon*.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

Collectors:—Bryan Patterson, Frank Letl and Paul C. Letl.

No. P 23311 Field Museum.

VERMES

The worms associated with *Lecthaylus gregarius* are generally fragmentary and poorly preserved. The two types so far discovered are briefly described here.

PROTOSCOLEX(?) RUEDEMANNI sp. nov. Plate XLIV, fig. 4.

Several poorly preserved impressions of a very thin, apparently segmented worm from the *Lecthaylus* beds are to be found in the Walker Museum collection, University of Chicago. All of the determinable characters of this organism are such as to indicate its close relationship to *Protoscolex*. Accordingly, it is tentatively referred to that genus. It could, however, be readily distinguished from *P.*

batheri Ruedemann and *P. latus* Bather, by its extreme thinness and by the relatively great length of the segments, which are in some cases three-fourths as long as wide. Some of the segments appear to be heavily papillose, but this is a feature not constantly shown in the material at hand.

The best preserved specimen is 28.5 mm. long and 1.1 mm. wide.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

No. 22375, Walker Museum, University of Chicago.

INCERTAE SEDIS.

Plate XLIV, figs. 5, 6.

A number of fragmentary fossils associated with *Lecthaylus* give the impression of possibly being those of worms. They are without marginal welts and can scarcely be referred to *Serpulites*. The surfaces of the fossils show impressions of a pebbly, leathery integument, similar to that described for *Dactylethra conspicua* Ruedemann,[1] but the shape, so far as it can be determined from the fragments, is very much more like that of the problematical fossil *Legnodesmus*, which Ehlers[2] described from the Solenhofen limestone, though no marginal swellings or any trace of segmentation (with the exception of a few extremely faint transverse lines) have been observed in the individuals thus far examined. There is a possibility that the specimens in question are seaweeds of some kind.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

Nos. 22374.1 and 22374.2 Walker Museum, University of Chicago.

Phylum MOLLUSCOIDEA
Class BRACHIOPODA Dumêril
Order NEOTREMATA Beecher
Superfamily DISCINACEA Waagen
Family DISCINIDAE Gray
Genus ORBICULOIDEA d'Orbigny

ORBICULOIDEA sp. Plate XLIV, fig. 7.

The brachiopods which have thus far come to light in association with *Lecthaylus gregarius* include one fairly well preserved pedicle valve and several fragmentary brachial valves.

[1] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, p. 44, Plate 15, fig. 12.

[2] Ehlers, E., Paleontographica, Vol. VII, 1868, p. 174, Plate 37, figs. 1, 2, 4, 5.

The pedicle valve is very similar to *Orbiculoidea molina* Ruedemann[1] from the Lowest Bertie waterlime, but probably is not conspecific with that form. Like the New York species, the surface of the Illinois specimen shows fine, concentric growth lines, but they do not become conspicuously coarser or lamellose toward the margin. On the other hand, the concentric lines of the specimen are crossed by fine, longitudinal striae. This specimen is also larger than the New York form, being 9 mm. long and 10 mm. wide.

The brachial valves, which may not belong to the same species or even the same genus as the pedicle, do not have the same configuration as those of *O. molina*. In fact, they exhibit a certain resemblance to *Trematis spinosa* Ruedemann,[2] from the Lockport. The specimens, however, are of such a fragmentary nature that they do not permit more satisfactory identification.

Horizon and locality:—Upper Lockport shale (Niagaran), Blue Island, Illinois.

No. 22376, Walker Museum, University of Chicago.

[1] Ruedemann, Rudolf, N. Y. State Mus., Bull. 189, 1916, p. 71, Plate 24, figs. 1–4.

[2] Ruedemann, Rudolf, N. Y. State Mus., Bull. 265, 1925, pp. 49-50, Plate 15, fig. 2.

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